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Brief Visuospatial Memory Test-Revised Normative Data For Ages 80-89

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Abstract
Memory testing is one of the primary methods for distinguishing normal age-related memory change from abnormal memory decline indicative of neuropathological conditions. However, this differentiation is made difficult by the substantial decline in memory test performance that occurs with normal aging. Memory tests that are clinically useful for younger patients are not for those age 60 and older because normal performance is low. Thus there is a low test score ceiling making it difficult to distinguish clinically significant memory impairment from normal age-related decline. While age-related decline in memory test performance occurs for verbal and visual-graphic memory tests, it is more pronounced for visual-graphic memory tests involving drawing. The Brief Visuospatial Memory Test-Revised (BVMT-R; Benedict, 1997) is a visual-graphic memory test that is clinically useful for the elderly because the content is easier thus avoiding problems inherent in tests with low score ceilings. However, a limitation of the test is that the norms extend only to age 79 and many patients referred for evaluation are in their 80's. The BVMT-R was administered to 50 adults. Forty-nine of the participant's scores were used to create norming data for two age groups, 80-84 and 80-89. The scores obtained from this sample were clinically different from those published in the test manual for ages 72-79. In fact, the decline in Total Recall scores from the 72-79 group in the manual to the 80-84 group in this study is larger than would be predicted based on age related differences between other age groups in the manual or the differences between the two age groups in this study. Implications of these findings are discussed.

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BRIEF VISUOSPATIAL MEMORY TEST-REVISED NORMATIVE DATA FOR AGES 80-89

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ABSTRACT

Memory testing is one of the primary methods for distinguishing normal age-related memory change from abnormal memory decline indicative of neuropathological conditions. However, this differentiation is made difficult by the substantial decline in memory test performance that occurs with normal aging. Memory tests that are clinically useful for younger patients are not for those age 60 and older because normal performance is low. Thus there is a low test score ceiling making it difficult to distinguish clinically significant memory impairment from normal age-related decline. While age-related decline in memory test performance occurs for verbal and visual-graphic memory tests, it is more pronounced for visual-graphic memory tests involving drawing. The Brief Visuospatial Memory Test-Revised (BVMT-R; Benedict, 1997) is a visual-graphic memory test that is clinically useful for the elderly because the content is easier thus avoiding problems inherent in tests with low score ceilings. However, a limitation of the test is that the norms extend only to age 79 and many patients referred for evaluation are in their 80's. The BVMT-R was administered to 50 adults. Forty-nine of the participant's scores were used to create norming data for two age groups, 80-84 and 80-89. The scores obtained from this sample were clinically different from those published in the test manual for ages 72-79. In fact, the decline in Total Recall scores from the 72-79 group in the manual to the 80-84 group in this study is larger than would be predicted based on age related differences between other age groups in the manual or the differences between the two age groups in this study. Implications of these findings are discussed.

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INTRODUCTION

It is well established that as individuals age, memory abilities decline (Albert, Duffy, & Naeser, 1987; Howieson, D., Holm, Kaye, Oken, & Howieson, J., 1993; Lezak, Howieson & Loring, 2004). Older adults may complain of forgetting names and places, losing items around the house, or having difficulties finding the right words. Memory problems are so commonplace and are enough of a concern that often, normal people are referred for a memory evaluation. In fact, memory declines are the most common concern for older adults who are referred for neuropsychological evaluations (Green, 2000). Memory declines beyond that associated with normal aging are characteristic of neurological pathology, Alzheimer's Disease (AD) being a primary concern because of the increased risk with increasing age (DSM-IV-TR, 2000). Neuropsychological evaluations of memory are often the only way to distinguish normal memory declines associated with aging from abnormal memory decline, especially in the early stages of progressive dementia (Albert, Moss, Tanzi & Jones, 2001). Reliable diagnosis is important in order to reassure patients with normal age associated memory decline and to identify patients with impaired memory who may need medical treatment.

Norming data is used to establish normal memory test performance, thereby providing a basis of comparison to identify memory impairment in those with neurological disease. Because of normal age-related memory decline, a person between 70-79 years of age with average memory skills will have an absolute score that is significantly lower than a person who is between 20-30 years of age. For example, decades ago Strother, Schaie and Horst (1956) found the mean performance for adults aged 70-88 was below that of a younger normative group. The largest and earliest declines occurred in memory, reaction speed and visuospatial abilities. Memory continues to change substantially after age 70, so much that normal memory test

performance is substantially different at ages 70, 75, 80 and 85. Additionally, norms for memory tests have established that normal age-related declines are more pronounced on visual-graphic memory tests that involve drawing than for verbal memory tests (Howieson et al., 1993; Koss, Haxaby, DeCarli, Schapiro et al., 1991). As a result, many visual-graphic memory tests that are clinically useful for younger patients are not for patients past age 70. Because normal performance for this age group is low, there is a low ceiling making it difficult to distinguish clinically significant memory impairment from normal age-related decline. The Brief Visuo-spatial Memory Test-Revised (BVMT-R; Benedict, 1997) is a visual-graphic memory test that is useful for memory assessment in the elderly because the content is easier and, unlike most visual-graphic memory tests, it includes multiple presentations to assess learning. However, a limitation of the test is that the norms extend only to age 79. Many patients referred for memory assessment are in their 80's. It is crucial to have norming data that is age appropriate and the utility of the BVMT-R would be substantially enhanced if norms were available for individuals in their eighth decade.

REVIEW OF LITERATURE

To place the importance of memory assessment of the elderly in proper context it is important to consider various aspects of memory function, pathology and evaluation. In the following pages, a cognitive model of memory will be presented, the normal cognitive aging process will be discussed, neurological diseases that affect memory will be reviewed, and the types of tests neuropsychologists use to assess memory will be outlined.

Memory as a Cognitive Process

Memory is complex and multidimensional. Traditionally, memory is broken into two categories, short-term (also known as attention and working memory) and long-term memory. Working memory is the brief, immediate memory for information that is currently being processed while long-term memory is information that is permanently stored and retrieved for later use (Matlin, 2005).

The information held in working memory is active and available so an individual can use the information to complete a variety of cognitive activities. There have been many theories to explain working memory and a commonly referred to model is the multicomponent model originally created by Alan Baddeley (1986). Baddeley's approach emphasizes that working memory is a multipart system that temporarily holds and manipulates information as cognitive tasks are being performed. According to Baddeley's model, working memory consists of four components: the phonological loop, the visuospatial sketchpad, the episodic buffer and the central executive.

The phonological loop is the portion of the working memory responsible for storing a limited number of sounds for a short period of time. The phonological loop stores sounds that are audible as well as inaudible, such as an inner voice. The visuospatial sketchpad stores visual and

spatial information as well as information that has been visualized from verbal stimuli. While it is possible to use the phonological loop and the visuospatial sketchpad at the same time it is not possible to perform two visuospatial tasks or two phonological tasks simultaneously. The episodic buffer has the ability to temporarily store information from the phonological loop, the visual spatial sketchpad, and long-term memory. The episodic buffer is a relatively new concept in the working memory model and its contribution is still being determined. The central executive does not store any information; rather, it integrates information from the phonological loop, the visuospatial sketchpad, and the episodic buffer. The central executive is responsible for filtering out irrelevant information. Although Baddeley's (1986) original model of working memory has been upheld over three decades of research, the construct of working memory continues to evolve and new research has shown that there may be more than two storage systems (Baddeley, 2003).

Long-term memory is the capacity to store memories of experiences and information accumulated over a lifetime. For simplicity, long-term memory can further be broken down into three subsets; however, this does not indicate that these three specific categories are distinctly different forms of memory. The three categories of memory include episodic memory, semantic memory and procedural memory (Tulving, 1972; Tulving, Schacter & Stark, 1982). Specific events that have occurred during a person's life form episodic memories. These memories allow a person to re-experience earlier episodes in their life. Semantic memories are organized knowledge about the world and other acquired factual information. Finally, procedural memory consists of an individual's knowledge about how to do something.

Processes in both working and long-term memory can be classified according to the type of incoming stimuli, for example, auditory-verbal vs. visual-graphic. Therefore, when studying

memory processes, researchers typically examine information presented both verbally and nonverbally. A verbal stimulus consists of anything pertaining to words whether audible or inaudible, whereas a nonverbal stimulus involves little or no language. In clinical memory assessment, the ability to retain, reproduce, and recognize information after the stimulus is no longer present is of most concern and these capacities are examined for both verbal and nonverbal information. For example, visual-graphic ability is a type of nonverbal skill that requires an individual to replicate drawings and understand various spatial relationships of figures and it is the ability to retain, reproduce, and recognize the visual-graphic information that is of utmost importance for memory assessment. The pattern of performance on verbal and visual-graphic memory tests can provide important diagnostic information when assessing the memory function of an older adult.

Normal Memory Function in Older Adults

Mild memory difficulties are commonplace among the elderly, sometimes making it difficult to diagnose memory deficits that may reflect neurological disease. However, understanding normal age-related changes in cognitive functioning aides in differentiating diseases such as Alzheimer's from normal memory decline (Hyman & Gómez-Isla, 1998). Normal declines in memory begin at about age 50, and substantial declines are notable as individuals enter their mid-70s (Albert, Duffy, & Naeser, 1987).

During memory evaluations, immediate and delayed memory is assessed (Lezak, Howieson & Loring, 2004). Both immediate and delayed memory are usually conceived as having three stages: encoding, storage and retrieval; as a result, during memory evaluations, an individual's ability to acquire, store and retrieve information in memory for both verbal and nonverbal domains should be tested (Lezak et al.). Encoding refers to the initial processing of

information; storage is the maintenance of the encoded information; and retrieval refers to the process by which the stored information is used (Neath & Suprenat, 2005).

There is strong evidence suggesting that as individuals age, encoding ability greatly declines as tasks become more difficult, and therefore more cognitive resources are required (Park, Smith, Morrell, Puglisi, & Dudley, 1990; Salthouse, Mitchell, Skovronek & Babcock, 1989; Smith, Park, Earles, Shaw & Whiting, 1998). For example, Park and researchers (1990) examined the effect of age on short-term memory abilities for unrelated and related pictures. The researchers reported large age differences between young and older adults when the task required more reliance on basic processing mechanisms (unrelated pictures) as compared to reliance on world knowledge (related pictures). Similarly, researchers have found that there are not many age-related differences in immediate memory for simple tasks that require rote maintenance abilities and for various forms of priming and recognition tasks. As task complexity increases, so does the performance differential between older and younger adults (Rueter-Lorenz & Sylvester, 2005). This research suggests that older adults are more susceptible to encoding difficulties but fare well during retrieval as they are able to recognize stimuli given to them on a memory task and perform better when they are primed.

Several studies have show that there are variations in memory performance between young and old age groups based on complexity of the stimuli, type of stimuli (verbal vs. nonverbal) and type of memory (procedural, semantic, episodic etc.), suggesting that there is a decline certain aspects of memory functioning as individuals age. For example, Dobbs and Rule (1989) assessed five groups ranging in age from 30-99 years on working memory tasks that ranged in complexity. The researchers found that for easier tasks, there were only slight variations in results among different ages and their age did not predict performance. Conversely,

for more complex tasks, the differences in performance were pronounced and age did predict performance. A later study by Bäckman & Farde (2005) noted that tasks that required procedural or semantic memory may or may not show age-related deficits, depending upon the difficulty of the task. However, this does not hold true when tasks require long term episodic or visual-graphic memory. There appears to be a marked age-related performance deterioration for these tasks regardless of complexity (Bäckman & Farde, 2005; Nebes, 1992; Park & Gutchess, 2005; Whalley, 2001; Wechsler, 1997). For episodic memory, deficits are more pronounced for free recall tasks whereas performance on recognition tasks is generally preserved throughout the aging process (Craik & Jennings, 1992). Test performance declines much more for visual tests that involve drawing than for verbal tests (Howieson et al., 1993; Koss et al., 1991). For example, Howieson and colleagues (1993) compared the neuropsychological results of 34 individuals aged 84-100 and 17 individuals aged 65-74 and found that the largest difference between the two age groups was a sharp decline on visual perceptual abilities for the older group. Performance on verbal measures between the two groups indicated that these abilities are relatively spared during the aging process. Overall, these findings suggest that as individuals age, there is a normal decline in memory functions based on complexity of the stimuli, type of stimuli, and type of memory.

Age related changes in performance on visual memory tasks that involve drawing are evident in the age norms for the Visual Reproduction subtests of the Wechsler Memory Scale-Third Edition (WMS-III; Wechsler, 1997). This test requires the examinee to draw figures that vary in complexity immediately after viewing the figures and after a 25-35 minute delay. The normative data for this test ranges from 17-89 years of age and highlights the decline in performance with advancing age. For example, at ages 65-70 a raw score between 31-36 is

needed to achieve a fiftieth percentile score. As individuals enter into their 80s the raw scores needed to achieve a fiftieth percentile score drop significantly: 28-33 for ages 80-84; 16-21 for ages 85-89. As individuals age, their visual-graphic memory skills decline and substantially lower performance is average.

The decline in visual memory abilities may be due to decreased activation in the hippocampus. In 2001, Iidaka and colleagues compared neural activations between young and old healthy adults while they memorized related, unrelated and abstract pictures for a subsequent recognition task. Through the use of functional magnetic reasoning imaging (fMRI) the researchers found that older adults showed lower levels of activation throughout the brain, with the main difference in the medial temporal areas where the hippocampus is located. Older adults also performed significantly lower on the memory task than the young adults. The age related decreases in hippocampal activity parallel the declines in memory performance and may possibly account for them.

Researchers have shown that there is a normal age-related decline that occurs with memory ability. This decline is most evident for encoding processes as well as for recalling difficult and complex information. Additionally, declines are greatest for episodic and visual-graphic information. There also is evidence that older adults show lower levels of activation in brain areas associated with memory.

Neurological Diseases Affecting Memory in Elders

Since there is normal age related cognitive decline, it can be difficult to distinguish benign decrements in function from actual underlying neurological disease. However, understanding normal decline as well as changes that occur because of a neurological disease greatly aid in making appropriate diagnoses. Knowledge of normal memory function in older

adults is not enough; knowledge of neurological diseases affecting memory in elders is also crucial. Although some memory loss is commonplace with the elderly, there are instances when the severity and pattern of memory loss may be evidence of dementia, such as occurs in Alzheimer's disease (AD), or another neuropsychological disorder (Hyman and Gomez, 1998).

Dementia is a syndrome characterized by multiple cognitive deficits including, but not limited to, memory, which is a prominent early symptom (DSM-IV-TR, 2000). The prevalence of dementia increases substantially as one ages. For individuals ages 65-69 between 1.4% to 1.6% experience dementia, a figure that rises to 16% to 25% for those over age 85 years (DSM-IV-TR, 2000).

The most common forms of dementia are slowly progressive, and eventually cause severe impairment in all aspects of memory and reasoning (Whalley, 2001). It is useful to classify dementing syndromes as either subcortical or cortical. These terms are associated with distinctive patterns of neuropsychological and neurobehavioral findings, which greatly aid clinicians in making diagnostic decisions (Green, 2000). For example, a subcortical dementia shows characteristics of mental slowing, forgetfulness, impaired ability to manipulate acquired knowledge, motor difficulties, personality changes, and depressed mood. Prototypical diseases of subcortical dementia include Supranuclear Palsy and Huntington's disease (Albert, Feldman, & Willis, 1974). In comparison, cortical dementias have characteristics of impaired acquisition, recall and recognition of information, as well as impairment in naming, word fluency, and visuospatial functioning (Green, 2000). The prototypical disease of cortical dementias is AD (Gómez-Isla et al., 1997).

Milberg and Albert (1989) compared individuals who had acquired dementia from Supranuclear Palsy (PSP; subcortical) and AD (cortical). Their subjects were 16 patients with

AD and 9 with PSP aged 61-85 years. They completed a series of neuropsychological tests and significant differences were found among the memory and language tasks. The researchers found that patients with AD had significantly lower scores on both verbal and non-verbal memory tests, while those with PSP were significantly more impaired on verbal fluency tasks. These findings support the notion that there are distinct neuropsychological patterns for cortical and subcortical dementias.

Distinguishing dementias as subcortical and cortical is useful and it is important to have knowledge of the specific types of dementia within those classifications. One type of dementia is frontotemporal dementia (FTD). Frontotemporal dementia affects language, cognition, and behavior. Neary and his colleagues (1998) established three subtypes of FTD; frontotemporal degeneration, progressive nonfluent aphasia and semantic aphasia.

Neary and researchers (1998) provided symptoms and neuropsychological findings for each subtype of FTD. Frontotemporal degeneration is marked by disordered social conduct, such as impairment in social regulation, emotional blunting and loss of insight. Additional symptoms include: decline in personal hygiene and grooming, mental rigidity and inflexibility, distractibility, dietary changes, and perseverative and stereotyped behavior. Neuropsychological findings show significant impairment on frontal lobe tests. Disorder of expressive language is the dominant feature in progressive nonfluent aphasia and may include agrammatism, phonemic paraphasia, and anomia. During neuropsychological testing, patients typically show nonfluent aphasia. Semantic aphasia is marked by impaired understanding of word meaning. Individuals may have fluent yet empty spontaneous speech as well as an impaired ability to name words and comprehend. Neuropsychological findings indicate that individuals with semantic aphasia show

semantic loss and failure to comprehend, while syntax, spatial skills and day to day memorizing abilities are preserved.

AD is one of the most common causes of dementia. One of the earliest manifestations of AD is memory impairment. Specifically, individuals with AD have impairments in recall and recognition for both verbal and nonverbal information (Rueter-Lorenz & Sylvester, 2005). Additionally, impairment in acquisition of new information remains a hallmark feature throughout the course of AD (Albert, 1998). It is important to note that mild memory difficulties are commonplace among the elderly population and therefore thorough, professional assessments are needed to determine whether the memory changes are a benign decrement in abilities or are in fact a result of a neurological disease.

Alzheimer's disease is a degenerative disorder that occurs predominantly in older adults. While memory deficits are the most common symptom of AD, especially in the early phases, other characteristics include difficulty naming objects, solving visuospatial problems and manipulating executive functions. Attention deficits are also common in people with AD (Knowlton, 2005). Three main phases have been identified for AD (Whalley, 2001). Initially individuals experience memory impairment, poor concentration and slight difficulties in completing every day tasks. Memory loss is not confined to one specific type of memory deficit as individuals with AD often exhibit problems with episodic memories followed by impairments in semantic knowledge as the disease progresses (Giffard et al., 2001; Grady, 2005; Knowlton; Weingartner, Grafman, Boutelle, Kaye & Martin, 1983). In the second stage, language is typically preserved but an individual may experience delusions or hallucinations, as well as abnormal foot withdrawal response and some facial weaknesses. Finally, language becomes severely impaired and eventually is lost completely. Individuals in this stage may not recognize

themselves or their relatives and they typically become incontinent, are unable to perform daily tasks, and often are bedridden.

Definitive diagnosis of AD is confirmed by detection of characteristic lesions in the limbic system and supported cortical areas. At death, about 30 percent of the cortical cells in the brain of an AD patients are necrotic, and those that survive often show decreased functioning with reduced dendritic sprouting and synaptic formations (Whalley, 2001).

AD often affects areas of the temporal and parietal lobes. The temporal lobes perform many functions such as processing auditory, visual and vestibular information, manipulate memory systems, and moderate temperament (Park & Gutchess, 2005). The parietal lobes contain the sensory cortex, language and visual association areas (Park & Gutchess; Whalley, 2001). Although these areas of the brain are responsible for many different functions, memory and visuospatial impairment are typically the most pronounced cognitive impairments in persons with AD (Park & Gutchess). Damage to these areas would cause a person with AD to have difficulty with easy memory tasks or drawing something as simple as a clock face (both tasks are sensitive tests for early AD; Whalley). Although more than memory loss is needed for a diagnosis of AD, memory impairment may be the only significant deficit at the very earliest stages of the disease. Neuropsychological evaluations of memory are paramount as they are often the only way to distinguish normal memory declines associated with aging from abnormal memory decline indicative of neurological disease (Albert et al., 2001).

Since both AD and frontotemporal dementias are diseases that affect older adults, neuropsychological assessments are crucial for a diagnosis of either disorder. Problem-solving difficulty, failure to comprehend with intact memory and nonfluent aphasia are indicative of FTD, while impaired orientation and memory suggest a diagnosis of AD. Since individuals with

neurological disease often show patterns of cognitive decline based on the type of disease, it is important to use neuropsychological tests that measure specific cognitive skills to obtain an accurate depiction of cognitive abilities. Understanding which neuropsychological tests are most commonly used with older adults as well as which cognitive aspects the tests are measuring is crucial for accurate diagnoses.

Neuropsychological Assessment of Memory

As noted above, declines in memory may be due to neurological diseases or the natural aging process. Performance on neuropsychological memory assessment provides essential information for accurate diagnostic decisions. Neuropsychological memory tests are almost exclusively based on episodic memory through the use of word lists, narratives, and reconstructing pictures (Spaan, Raaijmakers & Jonker, 2003). There are some tests that assess semantic memory (some verbal subtests from the WAIS-III, Wechsler, 1997; and Boston Naming Test, Goodglass & Kaplan, 2000) but these are typically not interpreted as memory tests (Spaan, et al.). Memory tests can be subdivided based on the modality of information to be memorized (verbal or nonverbal), the demands of replication of the material (free recall, cued recall, or recognition), and the length of time between the initial introduction to the stimulus and reproduction (immediate recall, delayed recall).

Memory tests are most often classified by the modality in which the example stimulus is presented. However, it is important to note that some nonverbal memory tests may contain stimuli susceptible to verbal encoding. Both verbal and nonverbal tests can be further classified according to the degree of complexity and the difficulty of reproduction requires. For example, a simple nonverbal test, such as the BVMT-R, contains individual geometric shapes, whereas the Rey-Osterrieth Complex Figure Test (Osterrieth, 1944; translated by Corwin & Bylsma, 1993)

contains several shapes that form a complex figure. The difficulty of reproduction required is based on whether stimuli are reproduced through free recall, cued recall, or recognition. Additionally, memory tests may require recall of information immediately after the initial presentation and/or after a 20-30 minute delay.

It is the pattern of performance among these different aspects of memory (modality, stimulus complexity, & difficulty of retrieval) that aid diagnostic decisions. Researchers have found that declines in certain memory abilities are better indicators of neurological disease, particularly for AD. For example, Elias and colleagues (2000) conducted a longitudinal study spanning 22 years with 1,043 non-demented participants aged 65-94. Over the years, the researchers identified 106 participants who met criteria for probable AD, and found significant differences between their test results and their non-demented counterparts on tests of episodic and semantic memory, specifically for tests of learning, immediate recall, and retention for narratives. Similarly, Bäckman, Small, and Fratiglioni (2000) compared individuals who developed AD (n = 15) with those who were non-demented (n = 105) three and six years prior to a dementia diagnosis. Researchers found that those with probable AD, performed significantly lower on tests of free recall and recognition of word lists than their non-demented counterparts. Grober and colleagues (2000) conducted a similar comparison with 264 initially non-demented elderly adults over the course of 10 years. They also found significant differences in scores between those who eventually met criteria for dementia and their non-demented counterparts on tests of free recall and recognition of word lists. The research in this area predominately examines neuropsychological tests of verbal memory and suggests that such tests are useful for predicting and diagnosing neurological diseases affecting memory (Ferma, Smith, Boeve, Graff-

Radford, Lucas, Knopman, et al., 2006; Linn, Wolf, Bachman, David, Knoefel, Cobb, et al., 1995; Small, Herlitz, Fratiglioni, Almkvist, Bäckman, 1997; Spaan, et al., 2003).

As evidenced above, the research examining memory declines in older adults is primarily on verbal memory tests. This may be due to the fact that many visual tests are complex and therefore may not be sensitive enough to find significant differences between normal age-related memory declines and those due to an underlying disease process. The normal age-related changes that occur make most visual memory tests insensitive to visual memory impairment in the elderly because of the low test score ceiling. In fact, Albert and researchers (2001) compared performance between those with dementia and those without on two visual-graphic memory tests. They did not find any significant differences between the groups' performance, but this is likely because the visual memory tests used, Visual Reproduction & Rey-Osterrieth Complex Figure, are complex and have a low test score ceiling for older adults. Visual memory tests with easier content may be more effective in detecting visual memory impairment in the elderly. In contrast to Albert's study, Zonderman and colleagues (1995) used a simpler visual test and found that individuals aged 55-95 with dementia scored significantly lower (both before diagnosis of dementia and after) on the visual memory test than their non-demented counterparts. The researchers used the Benton Visual Retention (BVR; Benton, 1974) test, which although simple, is limited because it assesses only immediate recall for geometric figures, with no evaluation of delayed recall or recognition. Together, these studies indicate simpler visual-graphic memory tests are useful to distinguishing normal from pathological memory changes in the elderly.

The BVMT-R is a visual-graphic memory test that not only contains simple visual stimuli, but also assesses immediate, delayed and recognition memory abilities (Benedict, 1997). During the test, patients view a display of six figures, arranged in a 2 X 3 matrix for 10 seconds.

After 10 seconds, patients recall the figures by reconstructing (drawing) them from memory. The patients are provided two additional 10 second exposures, followed by recall to assess learning over successive trials. Individuals are asked to recall the figures again 25 minutes later without any further exposure to the stimuli. Scoring is based on the respondent's accuracy and location of drawing the figures. Following the Delayed Recall trial, the respondent completes a recognition trial in which they are to determine whether certain figures were shown to them earlier. There are six forms that can be used to prevent prior exposure confounding results. According to the manual, the six forms are equivalent; however, subjectively some forms appear to be more difficult than other. Equivalency of the forms was assessed by testing 18 college students (mean age = 19.4) on all six forms with one-week intervals, and no significant difference was found between the performance on the difference forms. The generalizability of these results to older adults is questionable because this test is more complex for them due to the normal age-related decline in visual-graphic memory. Thus, subtle differences in difficulty among forms would be more evident for older adults. Equivalency of the forms was also examined by grouping participants into six groups (each group was tested using one of the six forms) and comparing their performances. A significant difference was not found between performances on the difference forms; however, the average age of participants was 39.25 and therefore the generalizability of these results to older adults is questionable.

Bennedict (1997) reported that the BVMT-R may be clinically useful in identifying visual memory impairment associated with AD. In 1996, Benedict and colleagues compared scores on the BVMT-R and the Trail Making Test (TMT) among participants who were diagnosed with dementia and normal elderly controls. There were 133 total participants: dementia of Alzheimer's type = 41, vascular or mixed dementia = 35 and controls = 57. The

groups were matched on age and education and large differences between the control and dementia groups appeared on both tests. The scores on all of the BVMT-R measures distinguished between the two groups with the exception of Response Bias.

The BVMT-R is useful for elderly adults because it is less complex than other visual memory assessments, thus is more specific for genuine memory impairment in this age group. Although useful for older adults, the BVMT-R has norming data available only up to age 79. Since there is rapid decline in memory test performance that normally occurs between the ages of 79 and 89, norms for individuals in their 70's are not valid for people in their 80's (Albert et al., 1987; Howieson et al., 1993; Wechsler, 1997). Because of the limited norms, the BVMT-R can not confidently be used with people in their 80's even though many patients referred for assessments are in this age group.

Gale and colleagues (2007) collected BVMT-R normative data for people aged 60-89 and examined gender differences between the Rey Auditory Verbal Learning Test and BVMT-R. There were 57 participants between the ages of 80-89 (19 male, 38 female). The researchers provided results for three variables on the BVMT-R (see Table 1). Although these findings provide invaluable information on the performance of individuals aged 80-89, it is unclear how these norms can be generalized to a larger population because the researchers used Form 4 of the BVMT-R instead of Form 1, which is likely the most widely used clinically. Gale and researchers used Form 4 of the BVMT-R to reduce the likelihood of prior exposure to their subjects who were participating in a research project. Although the manual states that these forms are comparable, subjectively Form 4 seems more difficult than others. Furthermore, the norms provided by Gale and researchers for individuals age 60-79 are considerably lower than the norms in the manual, suggesting that Form 4 may in fact be more difficult.

Table 1

Group Means and Standard Deviations for BVMT-R Scores Age 80-89 years (Gale et al., 2007)

	Men		Women		Total	
	M	SD	M	SD	M	SD
BVMT-R Total	13.5	5.1	15.0	6.1	14.6	5.8
BVMT-R Delayed Recall	6.2	2.8	6.5	2.9	6.4	2.8
BVMT-R Recognition	5.6	0.7	5.6	0.7	5.5	0.7

Purpose of the Study

The purpose of this study was to obtain normative data for individuals aged 80-89 on Form 1 of the BVMT-R.

Importance of the Study

The BVMT-R is particularly useful for elderly adults because it is less complex than other memory assessments and thus is more specific for genuine memory impairment in this age group. The BVMT-R has normative data for ages 18-79; however, as lifespan expectancy continues to increase, many patients in their eighth decade are referred for evaluation. Lack of normative data for individuals in this age range constrains the use of the BVMT-R. Thus it is important to obtain data for these older adults.

METHODOLOGY

Participants

Volunteers were all Caucasian, healthy, functionally independent persons solicited from churches and senior centers in Oregon. The sample included 50 participants ranging in age from 80 to 89, of whom 18 were males and 32 were females, 36% and 64% respectively. Mean level of education was 14 years with a range of 12-20. English was the primary language for all subjects. Participants completed a questionnaire and interview to screen for health problems and age-related diseases (see Appendix A for questionnaire) and were excluded if they had a history or evidence of a neurological or health problem, head trauma, past or present drug abuse, or psychiatric disorder that could interfere with their performance. Additionally, exclusion criteria also included scores greater than 8 on the Geriatric Depression Scale-Short Version (Sheikh & Yesavage, 1986), and scores less than 25 on the Mini-Mental state Examination (MMSE). One participant was excluded because of previously undiagnosed dementia.

The remaining 49 subjects were divided into two age groups: 80-84 ($n = 36$) and 85-89 ($n = 13$). There were no significant education differences for the groups ($F = .018$, $p = .895$). Mean MMSE scores for the age groups were: 80-84 = 29.4 (range = 27-30) and 85-89 = 28.9 (range = 26-30).

Procedure

Before beginning data collection, the researchers acquired Institutional Review Board approval (File Number 179-07). The volunteers were interviewed and assessed either at their home or at the church or senior center. All participants were assessed for: (1) verbal and visual-spatial intelligence with the Vocabulary and Block Design subtests of the Wechsler Adult Intelligence Scale – Third Edition (WAIS-III) (Wechsler, 1997), (2) cognitive mental status with

the Mini Mental State Exam (MMSE), (3) depression with the Geriatric Depression Rating Scale-Short Edition (Sheikh & Yesavage, 1986), (4) verbal memory with the Rey Auditory Verbal Learning Test (RAVLT) (Rey, 1964), and (5) visual-graphic memory with the BVMT-R (Bennedict, 1997).

All participants were informed of the study and their rights as participants and signed a consent form. Participants were interviewed to complete the neurological and health screening questionnaire. For participants that passed exclusion criteria, the researcher administered the tests in the following order: AVLT—initial learning portion, BVMT-R—initial recall portion, Block Design, Geriatric Depression Scale, AVLT—delayed recall and recognition, BVMT-R—delayed recall, recognition and copy, Vocabulary, and MMSE. The entire test battery took approximately 75 minutes. All assessments were conducted through standard administration.

RESULTS

The two age groups were created based on previous research that indicates there is a significant difference in visual-graphic memory test performance as individuals age, especially in their 8th decade (WMS-III; Wechsler, 1997). Descriptive statistics were computed to determine the average scores on all 12 variables of the BVMT-R for each group. Additionally, a Multivariate Analysis of Variance. (MANOVA) was conducted to determine if there were significant differences between the two groups on two variables of the BVMT-R (Total Recall Score, and Delayed Recall Score).

The mean score on a subtest of vocabulary was 11.64 (62nd percentile) for participants aged 80-84 and 11.69 (62nd percentile) for those aged 85-89. The average score on a performance subtest of constructing two-dimensional designs with blocks was 11.44 (62nd percentile) and 11.08 (62nd percentile) for 80-84 and 85-89 year olds respectively.

The mean score BVMT-R Total Recall Score for participants ages 80-84 was 14.72, and for the Delayed Recall Score was 6.03 (see table 2 for group means, standard deviations, and ranges for all 12 BVMT-R variables). The mean scores for the Total Recall Score and Delayed Recall Score for the participants aged 85-89 were 12.92 and 5.92 respectively (see table 3 for group means, standard deviations, and ranges for all 12 BVMT-R variables).

A one-way multivariate analysis of variance (MANOVA) was conducted to determine if there were significant differences between the two age groups on the Total Recall and Delayed Recall Score. Box's test of Equality of Covariance was significant and therefore Pillai's Trace was interpreted. There were no statistically significant differences between the two age groups' Total Recall score (F (1, 47) = .936, p = .338) or Delayed Recall score (F (1, 47) = .014, p = .905). However, the near 2 point difference in the Total score could be clinically significant and

small sample sizes reduced power to detect this. The scores for the remaining subtests, including Delayed Recall, were nearly identical for the groups.

The BVMT-R manual provides norms for individuals aged 72-79. According to these norms, the Total Recall Score of 20 is needed to achieve the 50th percentile for individuals aged 72-79, whereas 50th percentile scores in this study were 15 for ages 80-84 and 14 for those 85-89. The Delayed Scores in the manual appear to be closer to those of this sample. A score of 7 is needed to achieve 50th percentile for individuals aged 72-79, and for this sample a score 6 and 7 for 80-84 and 85-89 respectively is at the 50th percentile.

Table 2

Age 80-84 (N=36) Means, Standard Deviations and Ranges for BVMT-R Raw Scores

BVMT-R Scores	Mean	Std. Deviation	Minimum	Maximum
Trial 1	3.19	1.61	0	7
Trial 2	5.31	2.34	0	10
Trial 3	6.72	2.58	1	11
Total 1 + 2 + 3	14.72	5.90	2	27
Learning	4.28	3.40	-1	21
Delayed Recall	6.03	2.47	0	10
% Retained	85.03%	23.45	0	>100%
Hits	5.39	.76	4	6
False Alarms	.39	.76	0	3
Discrimination	5.0	1.01	2	6
Response Bias	.47	.18	.17	.88
Copy	11.75	.5	10	12

Table 3

Age 85-59 (N = 13) Means, Standard Deviations and Ranges for BVMT-R Raw Scores

BVMT-R Scores	Mean	Std. Deviation	Minimum	Maximum
Trial 1	2.46	1.13	1	4
Trial 2	4.62	2.02	1	8
Trial 3	5.85	2.76	1	11
Total Recall	12.92	5.27	5	23
Learning	3.69	1.97	1	7
Delayed Recall	5.92	3.25	0	11
% Retained	89.85%	24.59	40	>100%
Hits	5.31	.63	4	6
False Alarms	.31	.63	0	2
Discrimination	5.0	1.00	3	6
Response Bias	.41	.15	.17	.63
Copy	11.92	.277	11	12

DISCUSSION

The purpose of this study was to enhance the utility of the BVMT-R by providing norms for people in their eighth decade. This is important because memory assessment of older adults aids in determining if memory declines are part of the normal aging process or due to a neurological disease. The BVMT-R can be used in neuropsychological evaluation, and such evaluations are often the only way to distinguish normal memory declines associated with aging from abnormal memory decline indicative of AD, especially in the early stages (Albert et al., 2001). Reliably making this distinction is clinically important to identify patients that need treatment and help patients and families understand and cope if a neurological disease is diagnosed.

Since memory performance changes rapidly after the age of 75, it is critical to use appropriate norming data for tests. Norming data for individuals who are 79 can not be used for someone who is 84. Also, many current tests use complex graphics, and norms for memory tests have established that normal age-related declines are more pronounced on visual-graphic memory tests that involve drawing than for verbal memory tests (Howieson et al., 1993; Koss et al., 1991). As a result, many visual-graphic memory tests that are clinically useful for younger patients are not useful for patients past 70. Normal performance for this age group is low and therefore there is a low test score ceiling, which makes it difficult to distinguish between normal age-related decline and significant memory impairment. The BVMT-R is a practical alternative because the content is easier than many other visual-graphic memory tests and it includes multiple presentations to assess learning. However, a limitation is the norms extend only to age 79 and many patients referred for memory testing are in their 80's.

The preliminary results demonstrate the importance of visual memory test norms that are age specific for individuals in their 80's. There is a clinically significant difference between the BVMT-R Total Recall score for 72-79 year olds published in the test manual (Bennedict, 1997) and the score obtained by normal individuals in their 80's in this study. In fact, the decline in Total Recall scores from the 72-79 group in the manual to the 80-84 group in this study is larger than would be predicted based on age related differences between other age groups in the manual or the differences between the two age groups in this study. This raises the possibility that the normal samples in the manual and in this study were not comparable on some factor other than age. Additional normative studies will be needed to determine this.

In this study, only the difference on the Total Recall score for the groups was at a level that may be clinically significant. All other scores were nearly identical. While this suggests there may be little change in visual memory test performance, on Delayed Recall in particular, between these two age groups, this needs to be verified with larger sample sizes.

There is only one study that has attempted to obtain norming data for individuals aged 80-89 for the BVMT-R. Gale and colleagues (2007) assessed 57 older adults using Form 4 of the BVMT-R. Although the manual states that all forms are equivalent, subjectively (in the opinion of this researcher), Form 4 appears more complex than From 1, which is likely the most used clinically. The figures on Form 1 appear to be more common than the abstract figures on Form 4. Additionally, although the manual states that all forms of the BVMT-R are equal, it is not certain if the results from the sample used to assess equivalency can be generalized to older adults. Bennedict and colleagues (1996) conducted a "between subjects" design using the results from the 457 participants used to create norming data for the revised version. Although that data is helpful, a "within subjects" design provides the most accurate comparable data between the

forms. The researchers assessed 18 college students in a "within subjects" design and found no significant differences between forms, but again it is doubtful this finding can be generalized to individuals in their 7th and 8th decades. As noted above, the BVMT-R is useful for older populations because of its ease, and therefore it is not surprising that young adults would be able to perform well on all of the forms. However, older adults would be more sensitive to subtle differences of difficulty between forms, since visual-graphic abilities decline with age. Despite the fact that Form 4 appears more difficult than Form 1, the results from this study are similar to those in Gale's study. While Gale and colleagues reported that all participants were deemed healthy based on medical, neurologic, radiologic and functional examinations, there may be some differences between the subjects used in Gale's study and those used for this research. The subjects in Gale's study performed better on the AVLT than those in this study. For example, the mean score for the AVLT long delay in Gale's study was 8.45 whereas the mean score for this study was 5.98. Additionally, the scaled score for the WAIS III Vocabulary subtest was 13.4 for those in Gale's study and 11.51 for those in this study. This suggests that despite subjects in both studies being healthy, those in Gale's were higher functioning cognitively than those in this study. This could explain why average performance for the apparently easier Form 1 in this study is comparable to Gale's average scores for the more difficult Form 4. Gale's higher functioning subjects were able to obtain the same raw scores on the more difficult Form 4 as the lower functioning subjects in this study did on the less difficult Form 1.

Future normative studies with the BVMT-R are needed to attain a more accurate definition of normal visual-graphic memory abilities with older adults, and also to verify whether there are differences with visual-graphic memory ability between individuals in their early and

late 80's. Additionally, studies are needed to assess the equivalency between the different forms of the BVMT-R among older populations.

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APPENDIX A

Neurological and Health Screening Questionnaire

1. Demographics

ID Number:_____ Date of Questionnaire: _____

Age: _____ Gender: M F Marital Status: _____Education: _____

Current or retired from occupation: _____

2. Is the volunteer a native English speaker? **YES NO**

(The criteria are exclusionary as the tests given are designed, standardized, and valid measures only for English native speakers.)

3. Screening Questions:

Do any of the following apply to the volunteer, circle either "Yes" or "No." Obtain details of any yes answers.

Psychiatric History

Any psychiatric hospitalizations:	**YES**	**NO**
Has the subject received outpatient psychotherapy:	**YES**	**NO**
Has the subject taken psychotropic medications:	**YES**	**NO**
Has the subject experienced substance abuse or dependency:	**YES**	**NO**

Neurological/Medical

Has the subject experienced neurological or other medical problems:	**YES**	**NO**
Hospitalizations:	**YES**	**NO**
Stroke:	**YES**	**NO**
Head Trauma/Concussion	**YES**	**NO**
Respiratory Problems:	**YES**	**NO**
Gastrointestinal Problems:	**YES**	**NO**
Vascular Problems:	**YES**	**NO**
Endocrine Problems:	**YES**	**NO**
Liver Problems	**YES**	**NO**
Kidney Problems	**YES**	**NO**
Diabetes:	**YES**	**NO**
Cardiac Problems:	**YES**	**NO**
Hypoglycemia:	**YES**	**NO**
Anoxia/Hypoxia (*insufficient or no oxygen supply to the brain*):	**YES**	**NO**
Toxic Exposure:	**YES**	**NO**
Hypertension:	**YES**	**NO**
Surgery:	**YES**	**NO**
Injuries:	**YES**	**NO**
Post-Traumatic Amnesia:	**YES**	**NO**

Seizure Disorder: **YES** **NO**
Multiple Sclerosis: **YES** **NO**

List Medications

4. Current Medical Diagnoses
(*Indicate date of onset and treatment*)

_____

_____

_____

_____